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- NEWS OF THE WEEK

PHYSICS

Laser Light From a Handful of Dust

Alexander Hellemans[*]

Alexander Hellemans is a writer in Naples, Italy.

Physicists have sparked laser action in a light-trapping powder, they reported last month in *Physical Review Letters*. They say the effect, which causes the powder to radiate intense light in all directions, might one day be used to brighten some kinds of flat-panel displays.

Conventional lasers use a pair of mirrors to bounce a light wave back and forth through a cavity containing a material or gas whose atoms are “pumped” into a higher energy state by an external light source. Each time a photon hits an excited atom, the atom falls back to a lower energy state while emitting a photon with the same wavelength and direction. When enough atoms in the laser cavity are excited, the process can sharply amplify a light beam.

A team led by Hui Cao from Northwestern University in Evanston, Illinois, has produced a similar effect in a finely ground semiconductor powder. In 1997, a team of Dutch and Italian scientists, including Ad Lagendijk of the University of Amsterdam and Roberto Righini of the European Laboratory for Non-Linear Spectroscopy in Florence, Italy, demonstrated that such a powder can trap or “localize” light. Because of its high refractive index, the powder strongly scatters light waves, bouncing photons back and forth like balls in a pinball machine.

If the grains are close enough—less than the wavelength of the scattered light—the paths of the photons should form closed loops. “No matter which way [the waves] try to go, they will be scattered,” explains Cao. “Depending on the local configuration of the scatterers, you have different probabilities for loops.” As a result, the light passes many times through the same grains, just as an ordinary laser's light passes many times through the cavity between mirrors. “You can compare this with a cube made of six mirrors; a light wave will then run around continuously—just like in an optical cavity,” says Lagendijk. If the atoms in the grains have been pumped to a higher energy state, the process could amplify light.

To test this idea, the team at Northwestern University prepared powder films of zinc oxide and gallium nitride, with particles of about 100 nanometers in diameter. They shined laser light onto the films to pump their atoms. Then they directed a probe beam at the sample and measured the total intensity of the scattered light. The team noticed that when the pump laser reached a certain power, the intensity of the light emitted by the sample increased sharply, by 10 to 100 times. They concluded that the light was amplified; the powder had become a laser. “You are actually getting stimulated emission,” says team member Eric Seelig. “Light travels in those loops, and each of these closed loops forms a cavity.”

Righini says it's the first time researchers have demonstrated that laser amplification can take place in a powder. “The paper is rather convincing,” he says, predicting “this research will trigger more experiments.” One way to exploit the phenomenon, says Cao, might be to shrink the phosphor grains that emit light in flat-panel field-emission displays. In these displays, each pixel consists of a tiny electron emitter placed in front of a tiny screen. The electron emitter, says Cao, excites the atoms of the phosphor; in small enough grains, it might spark laser amplification and brighten the pixels. “We are working on that,” she says.